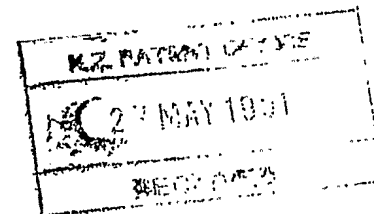


238275

Patents Form 5

Patent, 1 (1992)
Complete Specification 27.5.91
Inventor(s) A01J5/12, 14, F16K7/09, F16K43/00
28 OCT 1992
P.O. Number, etc. 1361



N.Z. No.

NEW ZEALAND

Patents Act 1953

COMPLETE SPECIFICATION

MILKING PULSATOR

We, ALFA-LAVAL AGRICULTURE INTERNATIONAL AB, a Swedish company of Farm Center, ~~P.O. Box 39~~, S-147 21 Tumba, Sweden, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:-

IV
mhc
5.11.91

Milking pulsator

The present invention relates to a milking pulsator for alternate connection of a source of vacuum to a number of teat cups. The milking pulsator comprises a housing forming a chamber, a vacuum passage to be connected to said source of vacuum and opening into the chamber via a first opening, and a pulsation channel to be connected to at least one of said teat cups and communicating with the chamber and with atmosphere via a second opening. The chamber is provided with a first valve means to close and open said first opening, and a second valve means to close and open said second opening. Means is provided for adjusting each valve means between an opened position and a closed position.

A milking pulsator of this kind is known from US 4,450,864. The known milking pulsator has its first and second valve means assembled into one single valve body with double valve cones connected to the housing via a membrane. The adjustment of the valve body is provided by alternately applying a pressure difference over the membrane by means of a slide valve controlled by a double acting solenoid. The current supply of the solenoid can be provided by for instance a rechargeable battery, which is relatively large in size because of the required power capacity. Thus, the membrane and the slide valve constitute components in a servo system, by means of which the required current consumption for adjusting the valve body can be kept relatively low. In comparison with the entirely pneumatically operated milking pulsators currently available in the market, the known electrically operated milking pulsator has the advantage that its rate and pulsation ratio can be

maintained substantially constant during a long period of operation.

However, the known electrically operated milking
5 pulsator has the drawback that it is substantially more
expensive than said pneumatically operated milking
pulsators. In addition, the necessary conduits between a
current source, for instance a battery, and the known
milking pulsator mean the existence of contacts. Such
10 contacts can easily corrode because of the damp environ-
ment, whereby the function of the milking pulsator is
jeopardized.

The object of the present invention is to provide a new
15 milking pulsator, which is inexpensive and can be
operated during a long period of time in a constant rate
and pulsation ratio. A further object of the present
invention is to provide a new electrically powered
milking pulsator enabling use of batteries small enough
20 to be encapsulated in the milking pulsator, whereby
corrosion sensitive contacts outside the milking
pulsator are avoided.

These objects are obtained by means of a milking
25 pulsator of the kind initially described, which mainly
is characterized in that each valve means comprises an
elongated flexible membrane with two ends, one of which
is attached to the housing, and a pivoted member, to
which the other end of the membrane is attached. Said
30 pivoted members of the first and second valve means are
journalled in the housing for pivotal motion back and
forth between closing positions, at which said first and
second openings are covered by the membrane of the first
valve means and the membrane of the second valve means,
35 respectively, and opening positions, at which said

openings are uncovered from the membranes. Said adjustment means is adapted to adjust the pivoted members of the first and second valve means, such that the first opening is closed when the second opening is uncovered and vice versa.

In consequence, the new milking pulsator will have the advantages that it will be inexpensive, since no servo system is needed to adjust the valve means; it can be operated electrically, for instance by means of a stepping motor, whereby a constant rate and pulsation ratio easily can be maintained during operation; and, in spite of the lack of a servo system, it will be low power consuming, since an extremely small force is sufficient to provide a membrane to roll off an opening of a channel, in which vacuum prevails. Membrane valves of the kind in question are described in WO 82/01924.

Suitably, the pivoted members of the first and second valve means are attached to a common shaft. By this said adjustment means can comprise one single motor for turning said common shaft back and forth.

When milking cows usually one of two different types of pulsation systems is used, namely either a type of pulsation system, in which all of the cow's four teats are milked simultaneously during each pulsation cycle, or another type of pulsation system, in which two pairs of the cow's teats are milked alternately, so that one pair of teats is milked simultaneously during a first pulsation cycle, whereas the other pair of teats is milked simultaneously during a second pulsation cycle, which is offset in phase relative to the first pulsation cycle. Usually each pulsation cycle has a duration of about one second. Since the new milking pulsator

primarily is intended to be used for said alternate milking of a cow's four teats, it is preferred that said pulsation channel is adapted to be connected to two of the teat cups, the housing forming a further chamber, into which a further vacuum passage to be connected to said source of vacuum opens via a third opening, and a further pulsation channel to be connected to the two other teat cups and communicating with said further chamber and with atmosphere via a fourth opening. In addition to this, a third valve means is arranged in said further chamber to close and open said third opening, and a fourth valve means is arranged to close and open said fourth opening. Said third and fourth valve means is of identical construction as that of the first and second valve means. Said adjustment means is adapted to adjust the pivoted members of the third and fourth valve means, such that the third opening is closed when the fourth opening is uncovered and vice versa.

Suitably, the pivoted members of the first and second valve means are attached to a common shaft, and the pivoted members of the third and fourth valve means are attached to a further common shaft. Said adjustment means comprises a separate motor for turning said common shaft back and forth, and a further separate motor for turning said further common shaft back and forth.

As an alternative, all of the pivoted members of the valve means may be attached to a common shaft, whereby said adjustment means only needs to have one single motor for turning said one common shaft back and forth.

In the new milking pulsator flow channels are formed between the pivoted members of the valve means and the

housing. Preferably, the pivoted member of at least one of the valve means is provided with an entrainment member, which is arranged such that it extends into and is displaced in the flow channel between the pivoted member and the housing during at least a substantial part of the turning of the pivoted member between said closing and opening positions. In consequence, the entrainment member is influenced by air flowing through the flow channel, as the membrane of the valve means uncovers its opening, and entrains the pivoted member towards the opening position of the valve means. Thus, the source of vacuum connected to the milking pulsator is utilized partly to operate the milking pulsator, which results in a reduced need for electrical energy for the operation of the milking pulsator.

Suitably, each pivoted member is provided with said entrainment member, which minimizes the need for electrical energy for the operation of the milking pulsator.

The need for electrical energy for the operation of the new milking pulsator may be further reduced by connecting each pivoted member provided with said entrainment member to an electro-magnetic stepping motor for said turning of the pivoted member. In addition to this the electro-magnetic stepping motor is connected to an electric accumulator via a control means, which is adapted to activate the electro-magnetic stepping motor for displacing the membrane of the pivoted member from said closing position, such that the membrane at least is displaced to the extent that the membrane starts uncover the opening associated with the membrane. Said control means is also adapted to control the electro-magnetic stepping motor, such that the latter operates

as a generator for charging the electric accumulator during the entrainment of the pivoted member by the entrainment member. If each pivoted member would be provided with an entrainment member and arranged in the manner described above with an electro-magnetic stepping motor and an electric accumulator, the new milking pulsator could be totally self-driving, provided that energy enough from the source of vacuum could be transformed to the electrical energy required for complete operation of the milking pulsator.

The new milking pulsator is primarily intended to subject the pulsation space in each teat cup to a pressure which pulsates between vacuum and atmospheric pressure during operation. However, it would of course be fully possible to modify the new milking pulsator for connection also to a source of overpressure, so that during operation the milking pulsator subjects each pulsation space to a pressure which pulsates between vacuum and overpressure without changing the principal function of the milking pulsator according to the invention.

The invention is described more closely in the following with reference to the accompanying drawing, in which

figure 1 shows a milking plant with a milking pulsator according to the invention,

figure 2 shows an embodiment of the milking pulsator according to the invention,

figure 3 shows a section along the line III-III in figure 2,

figures 4a and 5a show sections along the lines IV-IV and V-V, respectively, in figure 3,

5 figures 4b and 5b show the same sections as that of figures 4a and 5a, respectively, but with other adjustments of the valve means of the milking pulsator,

figures 6, 7 and 8 show side views of another embodiment of the milking pulsator according to the invention,

10 figure 9 shows a section along the line IX-IX in figure 8,

figure 10a, 11a and 12a show sectional views along the lines X-X, XI-XI and XII-XII, respectively, in figure 9, and

figures 10b and 10c; 11b and 11c; and 12b and 12c show the same views as that of figures 10a, 11a and 12a, respectively, but with other adjustments of the valve means of the milking pulsator.

The milking plant shown in figure 1 has four teat cups 1 with teat cup liners, a teat cup claw 2, to which the teat cups 1 are connected via four short milk tubes 3 and four short pulsation tubes 4, a milk transport conduit 5, which is connected to the claw 2 via a long milk tube 6, and a vacuum conduit 7, to which a milking pulsator 8 according to the invention is connected. Two long pulsation tubes 9, 10 extend between the milking pulsator 8 and the claw 2, and are connected to two pairs of the teat cups 1, respectively, via the claw 2 and the four short pulsation tubes 4.

The milking pulsator 11 shown in figures 2-5 comprises a housing 12, which has four valve chambers 13-16 with part cylindrical wall surfaces 17-20. In the valve chambers 13-16 there are valve means 21-24, respectively, comprising elongated membranes 25-28 and sector shaped pivoted members 29-32. Each valve means has one end of its membrane attached to the sector shaped pivoted member of the valve means, whereas the other end of the membrane of the valve means is attached to the housing, the membrane being extended a distance along the convex surface of the sector shaped pivoted member, being bent 180° from this to the wall of the valve chamber and being extended a distance along the part cylindrical surface of the valve chamber.

15 A pulsation channel 33 extends from a nipple 34 via the valve chamber 14 through the housing 12 and opens into the valve chamber 13 via an opening 35 in the part cylindrical surface 17. A further pulsation channel 36 extends from a nipple 37 via the valve chamber 16 through the housing 12 and opens into the valve chamber 15 via an opening 38 in the part cylindrical surface 18. Two vacuum passages 39 and 39a extend through the housing 12 and open into the valve chambers 14 and 16 via openings 40 and 41, respectively. The membranes 25-28 are arranged to cover and uncover the openings 35, 38, 40 and 41, respectively. The valve chambers 13 and 15 communicate with atmosphere via passages 42 and 43, respectively.

30 The pivoted members 29 and 30 are attached to a shaft 44, which is journaled in the housing 12 and which is turnable 90° between a first end position, at which the opening 35 is uncovered, while the opening 40 is covered by the membrane 26, and a second end position, at which

35

the opening 35 is covered by the membrane 25, while the opening 40 is uncovered. Correspondingly, the pivoted members 31 and 32 are attached to a shaft 45, which is journaled in the housing 12 and which is turnable 90°
5 between a first end position, at which the opening 38 is covered by the membrane 27, while the opening 41 is uncovered, and a second end position, at which the opening 38 is uncovered, while the opening 41 is covered by the membrane 28.

10

Two electro-magnetic stepping motors 46, 47 are connected to the shafts 44, 45, respectively, to turn these back and forth between said end positions. An electric accumulator 48 is connected to the stepping
15 motor 46 via a control means 49 and an electric accumulator 50 is connected to the stepping motor 47 via a control means 51.

Each pivoted member is provided with a wing 52, which
20 extends radially outwards from the convex surface of the pivoted member towards the part cylindrical wall surface of the valve chamber. Each wing 52 is located at one corner of the convex surface of the pivoted member of the wing 52, so that the membrane of the pivoted member
25 abuts against the convex surface of the pivoted member at the opening position of the pivoted member without being obstructed by the wing 52.

During milking the milking pulsator 11 operates in the
30 following manner:

Initially the milking pulsator 11 is attached to the vacuum conduit 7, the vacuum channels 39, 39a being connected to the interior of the vacuum conduit 7. The
35 pulsation tubes 9, 10 are connected to the nipples 34

and 37, respectively. In the positions of the valve means 21-24 shown in figures 4a and 5a atmosphere communicates with the interior of the pulsation tube 9 via the passage 42, the valve chamber 13, the pulsation channel 33 and the interior of the nipple 34, while the interior of the vacuum conduit 7 communicates with the interior of the pulsation tube 10 via the vacuum channel 39a, the valve chamber 16, the pulsation channel 36 and the interior of the nipple 37.

10

When the pressure conditions in the pulsation tubes 9, 10 are to be alternated the control means 49 first activates the stepping motor 46 by a pulse of current from the electric accumulator 48, so that the shaft 44 is turned clockwise at least as much such that the membrane 26 starts to uncover the opening 40. In consequence the space between the part cylindrical wall surface 19, the wing 52 of the pivoted member 30, the convex surface of the pivoted member 30 and the membrane 26 is evacuated, so that the resulted pressure difference across the wing 52 of the pivoted member 30 causes the wing 52 to entrain the pivoted member 30 to the position shown in figure 5b, the pivoted member 29 also being turned to the position shown in figure 4b. Soon thereafter the control means 51 activates the stepping motor 47 by a pulse of current from the electric accumulator 50, so that the shaft 45 is turned clockwise at least as much such that the membrane 27 starts uncover the opening 38. In the same manner as described above in connection with the entrainment of the pivoted member 30, the pivoted member 31 is entrained by its wing 52 to the position shown in figure 4b, the pivoted member 32 also being turned to the position shown in figure 5b.

During the entrainment of the pivoted members 30 and 31 the electro-magnetic stepping motors 46, 47 act as generators and charge the electric accumulators 48, 50 with electrical energy. Thus, pressure energy from the source of vacuum, which is connected to the vacuum conduit 7, is also transformed into electrical energy to operate the milking pulsator, so that this in principle can be totally operated by said source of vacuum.

With the valve means 21-24 in the positions shown in figures 4b and 5b atmosphere communicates with the interior of the pulsation tube 10 via the passage 43, the valve chamber 15, the pulsation chamber 36 and the interior of the nipple 37, whereas the interior of the vacuum conduit 7 communicates with the interior of the pulsation tube 9 via the vacuum channel 39, the valve chamber 14, the pulsation channel 33 and the interior of the nipple 34. When the pressure conditions in the pulsation tubes 9, 10 are to be alternated again the control means 51 first activates the stepping motor 47 and soon thereafter the control means 49 activates the stepping motor 46, so that the pivoted members 29-32 are turned anti-clockwise back to the positions shown in figures 4a and 5a. During each pulsation cycle the vacuum phase thus has a longer duration than the atmospheric phase.

The operation described above is repeated until the milking is finished.

The milking pulsator 53 shown in figures 6-12 comprises a housing 54, which has three valve chambers 55-57 with circular cross-sections arranged coaxially. A pulsation channel 58, which extends from a nipple 59 through the housing 54, communicates with the valve chamber 57 and

- with the valve chamber 55 via a passage 60. A further pulsation channel 61, which extends from a nipple 62 through the housing 54, communicates with the valve chamber 56 and with the valve chamber 55 via a passage 62A. Two vacuum passages 63 and 64 extend through the housing 54 and open into the valve chambers 56 and 57, respectively. The valve chamber 55 communicates with atmosphere via two passages 65 and 66.
- 10 A first circular cylindrical pivoted member 67 is arranged in the valve chamber 55 coaxially with the latter and is provided with two elongated membranes 68 and 69 to open and close the passages 60 and 62A, respectively. A second circular cylindrical pivoted
- 15 member 70 is arranged in the valve chamber 56 coaxially with the latter and is provided with an elongated membrane 71 to open and close the vacuum passage 63. A third circular cylindrical pivoted member 72 is arranged in the valve chamber 57 coaxially with the latter and is
- 20 provided with an elongated membrane 73 to open and close the vacuum passage 64.

- The pivoted members 67, 70 and 72 are attached to a shaft 74, which is journalled in the housing 54 and
- 25 which is turnable 90° between a first end position (figures 10a, 11a, 12a), at which the passages 60 and 63 are uncovered, while the passages 62A and 64 are covered by the membranes 69 and 73, respectively, and a transition position (figures 10b, 11b, 12b) at which the
- 30 passages 63 and 64 are uncovered, while the passages 60 and 62A are covered by the membranes 68 and 69, respectively. In addition to this the pivoted members 67, 70 and 72 are turnable 90° between said transition position and a second end position (figures 10c, 11c,
- 35 12c), at which the passages 62 and 64 are uncovered,

11A7 02
10 157 782

while the passages 60 and 63 are covered by the membranes 68 and 71, respectively.

5 An electro-magnetic stepping motor 75 is connected to the shaft 74 to turn this back and forth between said end positions. A battery 76 for driving the stepping motor 75 is connected to this via a control means 77.

10 The milking pulsator 53 operates in the following manner:

The milking pulsator 53 is attached to the vacuum conduit 7, the vacuum passages 63, 64 being connected to the interior of the vacuum conduit 7. The pulsation tubes 9, 10 are connected to the nipples 59 and 62, respectively. In the positions of the pivoted members 67, 70, 72 shown in figures 10a, 11a and 12a atmosphere communicates with the interior of the pulsation tube 9 via the passages 65 and 66, the valve chamber 55, the passage 60, the pulsation channel 58 and the interior of the nipple 59, whereas the interior of the vacuum conduit 7 communicates with the interior of the pulsation tube 10 via the vacuum passage 63, the valve chamber 56, the pulsation channel 61 and the interior of the nipple 62.

When the pressure conditions in the pulsation tubes 9, 10 are to be alternated the control means 77 activates the stepping motor 75 with current from the battery 76, so that the shaft 74 and the pivoted members 67, 70 and 72 first are turned clockwise 90° to said transition position according to the positions shown in figures 10b, 11b and 12b, the interior of the vacuum conduit 7 communicating with the interior of the two pulsation tubes 9, 10. The pivoted members 67, 70 and 72 remain

13 SEP 1992

for a while in said transition position. This means that during each pulsation cycle the milking phase, i.e. when the teat cup liners in any of the pairs of teat cups are kept open because of exterior influence by the source of vacuum, will be longer than the rest phase, i.e. when said teat cup liners are kept closed because of influence by the pressure difference between atmospheric pressure acting externally on the teat cup liners and the milking vacuum prevailing in the interior of the teat cup liners. Soon thereafter the pivoted members 67, 70 and 72 are turned further 90° to the positions shown in figures 10c, 11c and 12c. In these positions atmosphere communicates with the interior of the pulsation tube 10 via the passages 65 and 66, the valve chamber 55, the passage 62A, the pulsation channel 61 and the interior of the nipple 62, whereas the interior of the vacuum conduit 7 communicates with the interior of the pulsation tube 9 via the vacuum passage 64, the valve chamber 57, the pulsation channel 58 and the interior of the nipple 59.

When the pressure conditions in the pulsation tubes 9, 10 are to be alternated again, the control means 77 activates the stepping motor 75, so that the pivoted members 67, 70 and 72 first are turned anti-clockwise 90° to said transition position and thereafter are turned further 90° to the positions shown in figures 10a, 11a and 12a.

The above described operation of the milking pulsator 53 is repeated until the milking is finished.

The milking pulsator 53 may have a lower current consumption if the pivoted members 67, 70 and 72 are provided with wings analogous to the wings 52 in the

SECRET
10 SEP 1991

above described milking pulsator 11. In addition to this the current consumption may be further reduced if the battery 76 is replaced by an electric accumulator, which is charged by means of the electro-magnetic stepping
5 motor 75. Thus, this acts as an electric generator, when the pivoted members 67, 70 and 72 are entrained by said wings.

What We Claim Is:-
Claims

1. A milking pulsator for alternate connection of a source of vacuum to a number of teat cups, comprising a housing, forming a first chamber, a vacuum passage to be
5 connected to said source of vacuum and opening into the first chamber via a first opening, a second chamber communicating with atmosphere, and a pulsation channel to be connected to at least one of said teat cups and
10 communicating with the first chamber and with the second chamber via a second opening, a first valve means in the first chamber to close and open said first opening, a second valve means in the second chamber to close and open said second opening, and means for adjusting each
15 valve means between an open position and a closed position, c h a r a c t e r i z e d i n that each valve means comprises an elongated flexible membrane with two ends, one of which is attached to the housing, and a pivoted member, to which the other end of the
20 membrane is attached, said pivoted members of the first and second valve means being journaled in the housing for pivotal motion back and forth between closing positions, at which said first and second openings are covered by the membrane of the first valve means and the
25 membrane of the second valve means, respectively, and opening positions, at which said openings are uncovered from the membranes, and that said adjustment means is adapted to adjust the pivoted members of the first and second valve means, such that the first opening is
30 closed when the second opening is uncovered and vice versa.

2. A milking pulsator according to claim 1, c h a r a c t e r i z e d i n that the pivoted members of

the first and second valve means are attached to a common shaft.

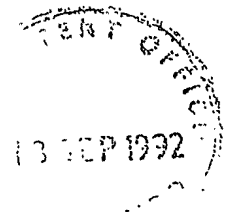
3. A milking pulsator according to claim 2, c h a -
5 r a c t e r i z e d i n that said adjustment means
comprises a motor for turning said common shaft back and forth.

10 4. A milking pulsator according to claim 1 for alter-
nate connection of said source of vacuum to four teat
cups, the pulsation channel adapted to be connected to
two of the teat cups, and the housing further forming a
third chamber, into which a further vacuum passage to be
15 connected to said source of vacuum opens via a third
opening, and a fourth chamber, into which a further
pulsation channel to be connected to the two other teat
cups opens via a fourth opening, said further pulsation
channel communicating with the third chamber, said
20 fourth chamber communicating with atmosphere, the
milking pulsator further comprises a third valve means
arranged in said third chamber to close and open said
third opening, and a fourth valve means arranged in
said fourth chamber to close and open said fourth
opening, said third and fourth valve means being of
25 identical construction as that of the first and second
valve means, c h a r a c t e r i z e d i n that
said adjustment means is adapted to adjust the pivoted
members of the third and fourth valve means, such that
the third opening is closed when the fourth opening is
30 uncovered and vice versa.

5. A milking pulsator according to claim 4, c h a -
r a c t e r i z e d i n that the pivoted members of
the first and second valve means are attached to a
35 common shaft, and that the pivoted members of the third

and fourth valve means are attached to a further common shaft.

- 5 6. A milking pulsator according to claim 5, c h a -
r a c t e r i z e d i n that said adjustment means
comprises a separate motor for turning said common shaft
back and forth, and a further separate motor for turning
said further common shaft back and forth.
- 10 7. A milking pulsator according to claim 4, c h a -
r a c t e r i z e d i n that all of the pivoted
members of the valve means are attached to a common
shaft.
- 15 8. A milking pulsator according to claim 7, c h a -
r a c t e r i z e d i n that said adjustment means
comprises a motor for turning said common shaft back and
forth.
- 20 9. A milking pulsator according to any of the preceding
claims, in which flow channels are formed between the
pivoted members of the valve means and the housing,
c h a r a c t e r i z e d i n that the pivoted
member of at least one of the valve means is provided
25 with an entrainment member, which is arranged such that
it extends into and is displaced in the flow channel
between the pivoted member and the housing during at
least a substantial part of the turning of the pivoted
member between said closing and opening positions,
30 whereby the entrainment member is influenced by air
flowing through the flow channel, as the membrane of the
valve means uncovers its opening, and entrains the
pivoted member towards the opening position of the valve
means.



10. A milking pulsator according to claim 9, c h a -
r a c t e r i z e d i n that each pivoted member is
provided with a said entrainment member.

5 11. A milking pulsator according to claim 9 or 10,
c h a r a c t e r i z e d i n that each pivoted
member provided with said entrainment member is con-
nected to an electro-magnetic stepping motor for said
turning of the pivoted member, said electro-magnetic
10 stepping motor being connected to an electric accumu-
lator via a control means, which is adapted to activate
the electro-magnetic stepping motor for displacing the
membrane of the pivoted member from said closing
15 position, such that the membrane at least is displaced
to the extent that the membrane starts to uncover the
opening associated with the membrane, said control means
also being adapted to control the electro-magnetic
stepping motor, such that the latter operates as a
20 generator for charging the electric accumulator during
the entrainment of the pivoted member by the entrainment
member.

12. A milking pulsator substantially as herein described
with reference to the accompanying drawings.

ALFA-LAVAL AGRICULTURE INTERNATIONAL AB

By their attorneys

HENRY HUGHES LTD

Per: 

PATENT OFFICE
18 SEP 1992

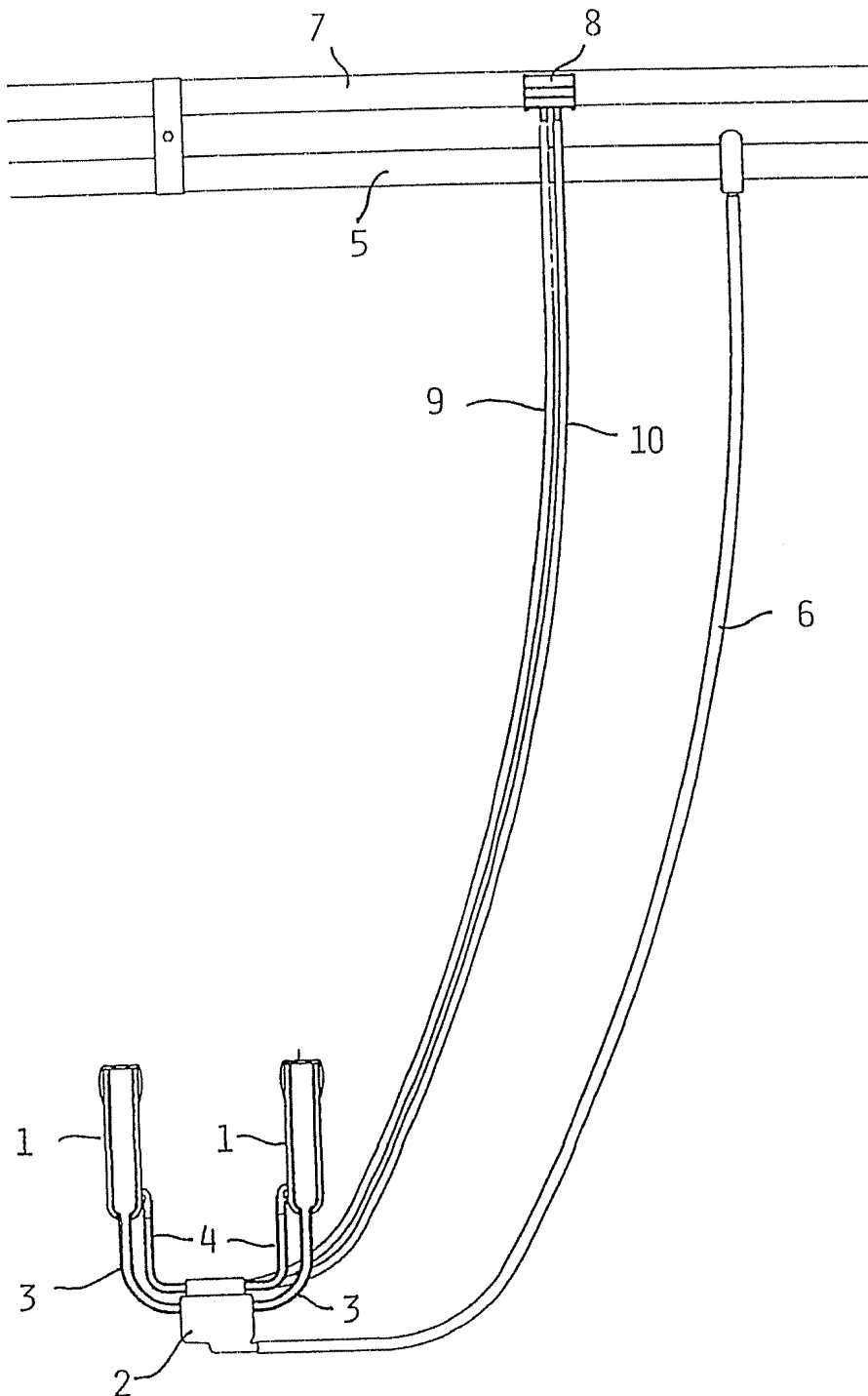


FIG. 1

ALFA-LAVAL AGRICULTURE INTERNATIONAL AB
By Their Attorneys
HENRY HUGHES LTD
Per: *[Signature]*

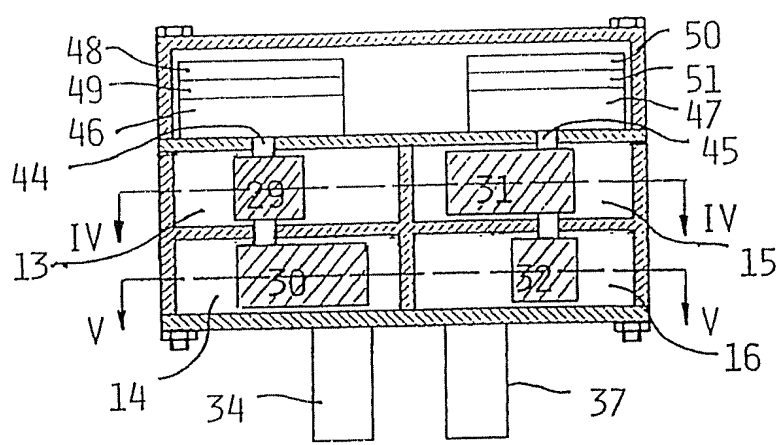


FIG. 3

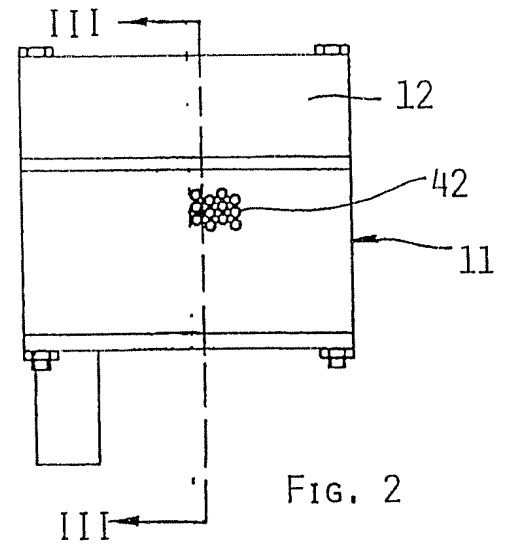


FIG. 2

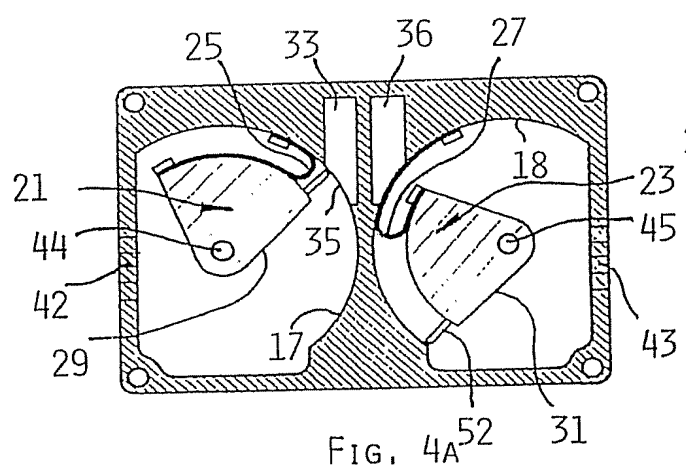


FIG. 4A

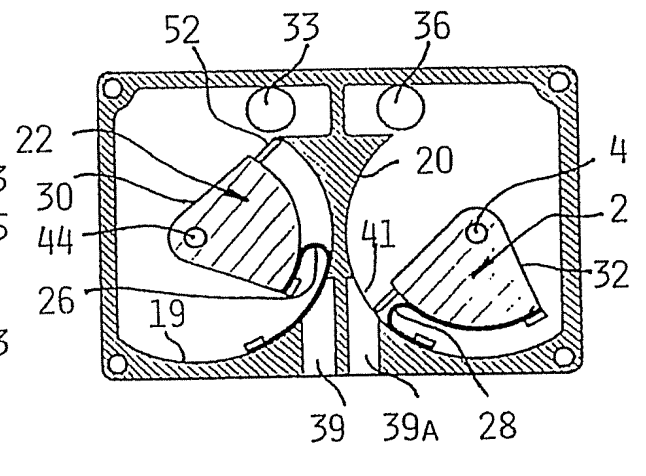


FIG. 5A

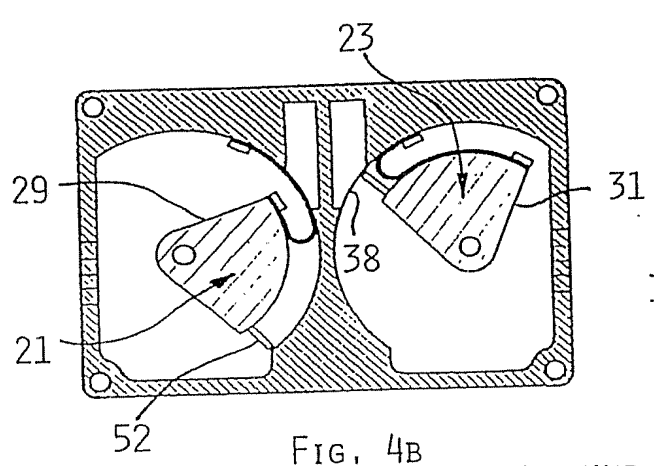


FIG. 4B

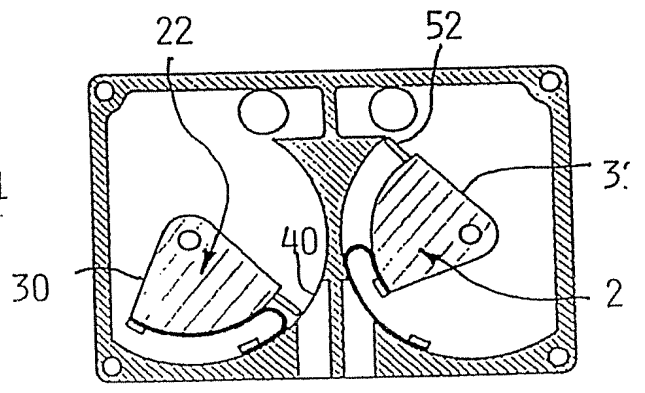


FIG. 5B

ALFA-LAVAL AGRICULTURE INTERNATIONAL
By Their Attorneys
HENRY HUGHES LTD
Per: *[Signature]*

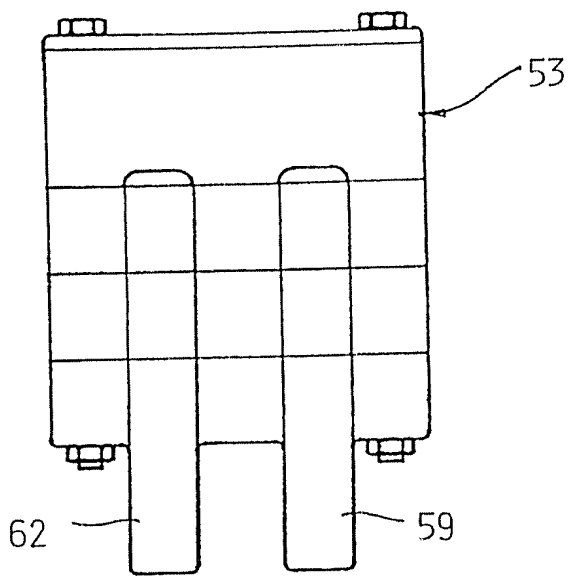


FIG. 6

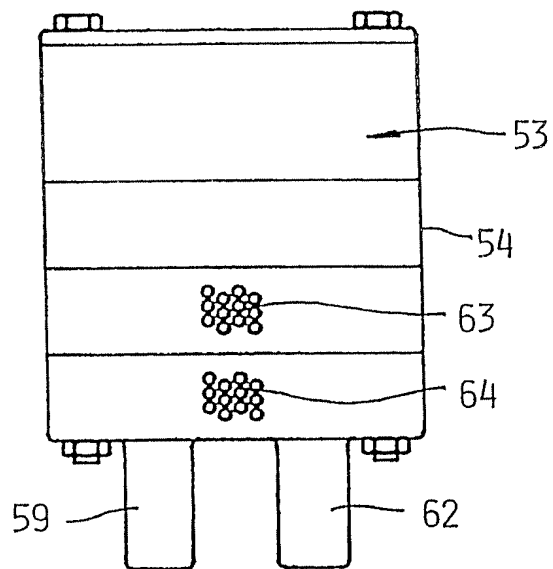


FIG. 7

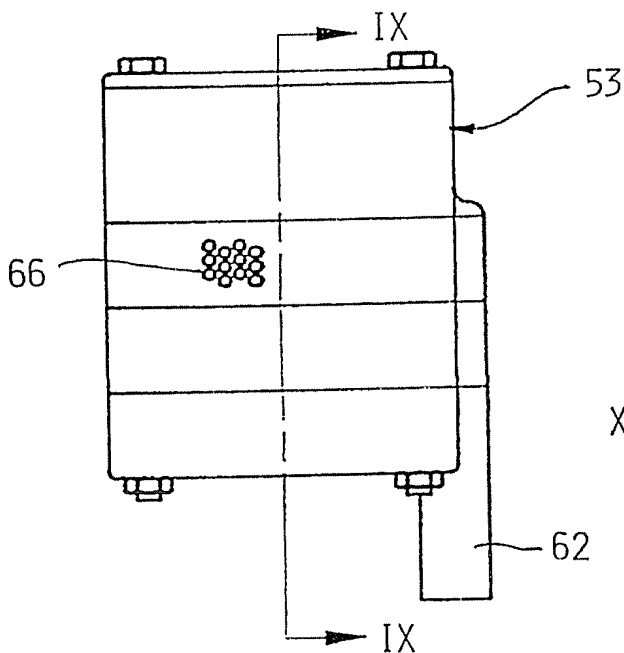


FIG. 8

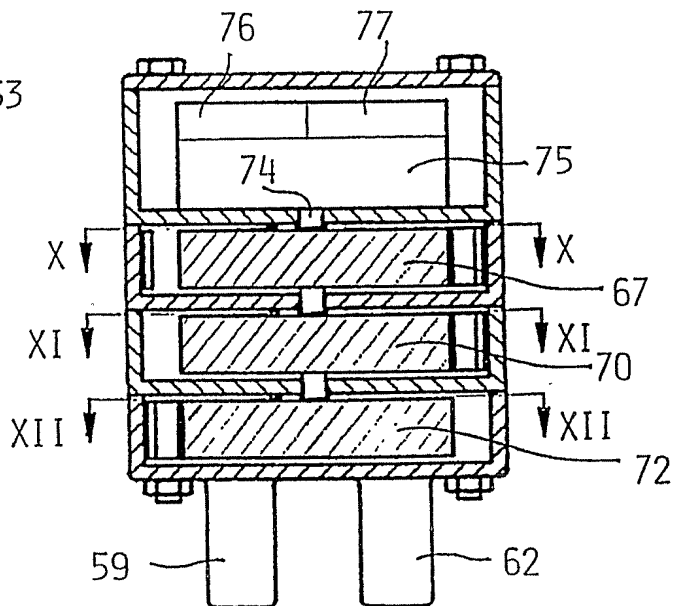


FIG. 9

ALFA-LAVAL AGRICULTURE INTERNATIONAL AB
By Their Attorneys
HENRY HUGHES LTD
Per: *[Signature]*

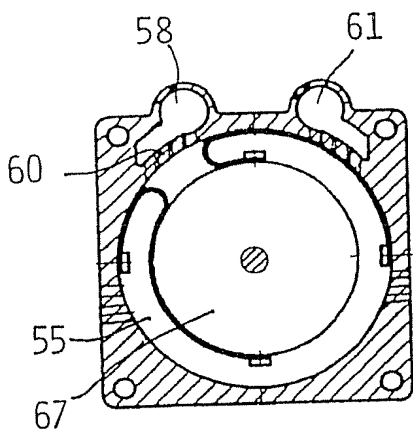


FIG. 10A

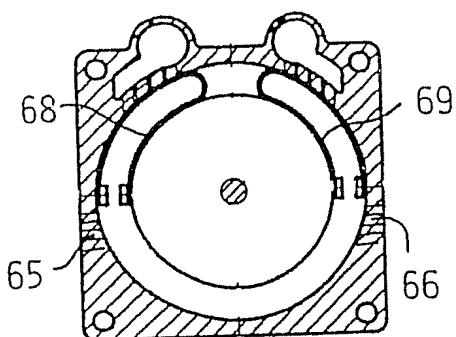


FIG. 10B

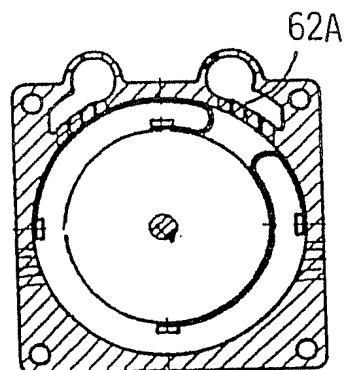


FIG. 10C

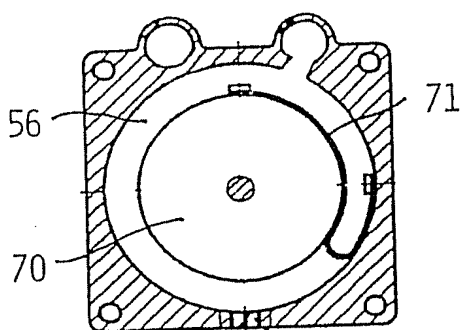


FIG. 11A

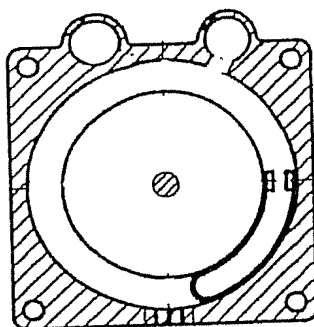


FIG. 11B

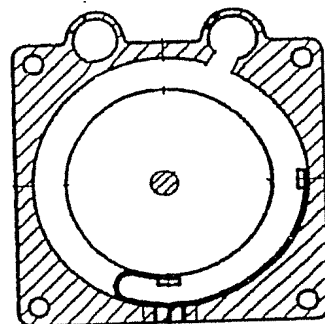


FIG. 11C

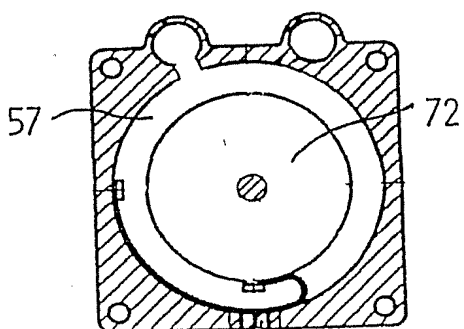


FIG. 12A

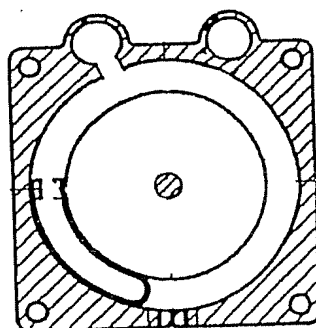


FIG. 12B

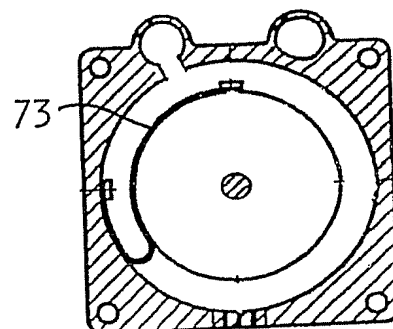


FIG. 12C

ALFA-LAVAL AGRICULTURE INTERNATIONAL AB
By their attorneys
HENRY HUGHES LTD
Per: *JHC*

END